Claims

1. Device for the photorealistic representation of dynamic, complex, three-dimensional scenes by means of ray-tracing, wherein said device has at least one programmable ray-tracing processor in which are implemented:

- special traversing instructions and/or
- vector arithmetic instructions and/or
- instructions for establishing ray-tracing acceleration structures and/or
- at least one decision unit (mailbox), which prevents objects or triangles that have already been intersected by a ray cast during ray tracing from being intersected again by the ray.

and wherein the device is organized in such manner as to allow a plurality of threads to be processed in parallel and to allow a plurality of threads to automatically be processed synchronously, and wherein the device is provided with an n-level cache hierarchy and/or virtual memory management and/or a direct link to the main memory.

2. Device for the photorealistic representation of dynamic, complex, three-dimensional scenes by means of ray tracing, wherein said device has at least one special traversal unit, at least one list unit, at least one decision unit (mailbox) which prevents objects or triangles that have already been intersected by a ray cast during ray tracing from being intersected again by the ray, at least one intersection-computation unit, at least one unit for establishing acceleration structures, at least one transformation unit and/or at least one unit for solving linear equation systems, and wherein a plurality of rays or threads may be processed in parallel and a plurality of rays or threads may automatically be processed synchronously and an arbitrary number of dynamic-object levels may be realized in dynamic objects, and wherein the device is provided with an n-level cache hierarchy and/or virtual memory management and/or a direct link to the main memory.

3. Device according to claim 1, wherein said device has at least one special traversal unit, at least one list unit, at least one decision unit (mailbox) which prevents objects or triangles that have already been intersected by a ray cast during ray tracing from being intersected again by the ray, at least one intersection-computation unit, at least one unit for establishing acceleration structures and at least one ray-tracing processor.

4. Device according to claims 1, 2 or 3, wherein the at least one unit for establishing acceleration structures is realized by means of special hardware or by programmable units or ray-tracing processors, and functionally carries out processes for creating the data structure for the acceleration structure and for deciding whether a triangle or a box

overlaps another box, the at least one unit basing the decision on comparisons of the vertices of the triangle or box with the vertices of the second box and – if no decision is possible – making a conservative decision or, in this case, starting a program on the programmable ray-tracing processor, with said program making the exact decision, or an additional, special hardware unit makes the exact decision or the entire computation takes place on the ray-tracing processor.

5. Device according to claims 3 or 4, wherein the at least one transformation unit and/or the at least one logic unit for solving linear equation systems is used functionally for primary-ray generation and/or object-space transformation and/or normalized-triangle-space transformation and/or reflection-ray computation and/or transparency-ray computation and or shadow-ray computation and/or the transformation of normals.

6. Device according to one of the claims 1 to 5, wherein the at least one traversal unit or traversal instruction is able not only to traverse along a ray but is also able to traverse a volume, so that all objects within this volume can be processed.

7. Device according to one of the claims 1 to 6, wherein the at least one traversal unit or traversal instruction is able not only to traverse along a ray but also along a ray cone or a ray pyramid, so that all objects located within the ray cone or the ray pyramid can be processed from front to back.

8. Device according to one of the claims 1 to 7, wherein the function of the at least one traversal unit and the hardware implementation of the traversing instructions are based on the fact that a ray is traversed through an acceleration structure based on the kD-tree technique or the octree technique or the uniform-grid technique or the bounding-volume-hierarchy technique, with simplified geometry data being stored in each acceleration-structure node and being used as soon as the ray cone under consideration passes through the bigger part of the volume belonging to this node.

9. Device according to one of the claims 1 to 6, wherein a plurality of ray-tracing units operate in parallel on a plurality of chips and/or a plurality of printed circuit boards.

10. Device according to one of the claims 1 to 9, wherein the described ray-tracing hardware additionally uses a space-dividing data structure in which spatial influences and/or material-modifying parameters are stored, which are evaluated with the already available and/or additional functional units.

11. Device according to one of the claims 1 to 10, wherein the ray-tracing hardware processes three-dimensional scenes that are not built up exclusively from triangles but

also contain other geometric objects which, where necessary, are transformed into different geometric objects and/or processed directly with additional and/or already available functional units and/or the programmable ray-tracing processor.

12. Device according to one of the claims 1 to 11, wherein the described ray-tracing hardware processes three-dimensional scenes and computes several, one or no ray-object intersections, sorted or unsorted according to the distance, per ray, where the number of ray-object intersections may be defined as a constant and/or described by additional object parameters.

13. Device according to one of the claims 1 to 12, wherein the described ray-tracing hardware is able, using additional and/or the already available functional units, to count how often a dynamic and/or geometric object and/or a material description and/or an element and/or a subgroup of the space-description data structure and/or a program and/or a memory cell and/or a memory page was used to compute an image.

14. Device according to one of the claims 1 to 13, wherein the described ray-tracing hardware is able, using additional or the already-available functional units, to compute space-description data structures for partial or complete three-dimensional scenes, with additional parameters for each dynamic object and/or dynamic sub-object and/or geometric object influencing the manner in which the space-description data structure is computed.

15. Device according to one of the claims 1 to 14, wherein the described ray-tracing hardware is connected via a shared z buffer and frame buffer with rasterization hardware that is located on the same chip as the ray-tracing hardware or on a separate chip.

16. Device according to one of the claims 1 to 15, wherein a plurality of ray-tracing units operate in parallel and the required computation data is distributed on the memories of these ray-tracing units and when needed, is downloaded from whichever unit the required data is stored in.